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Convergence analysis of a pressure-robust space-time HDG method for incompressible flows

Much of the recent progress in the numerical solution of incompressible flow problems has concentrated on pressure-robust finite element methods, a class of mimetic methods that preserve a fundamental invariance property of the incompressible Navier–Stokes equations. Two essential ingredients are required for pressure-robustness: exact enforcement of the incompressibility constraint, and H(div)-conformity of the finite element solution.

In this talk, I will introduce a space-time hybridized discontinuous Galerkin finite element method for the evolutionary incompressible Navier–Stokes equations. The numerical scheme has a number of desirable properties, including pointwise mass conservation, energy stability, and higher-order accuracy in both space and time. Through the introduction of a pressure facet variable, H(div)-conformity of the discrete velocity solution is enforced, ensuring the numerical scheme is pressure-robust.

Well-posedness of the resulting nonlinear algebraic system will be considered, and uniqueness of the discrete solution will be shown in two spatial dimensions under a small data assumption. A priori error estimates for smooth solutions will be presented, as well as convergence to weak solutions in the sense of Leray and Hopf using compactness results for discontinuous Galerkin methods.